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USSR Report

ENGINEERING AND EQUIPMENT

No. 67

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USSR

UDC 621.3.019.34

PROBLEMS IN DIAGNOSING AND FORECASTING POWER EQUIPMENT RELIABILITY

Moscow IZVESTIYA AKADEMII NAVK SSSR: ENERGETIKA I TRANSPORT in Russian No 6, Nov Dec 79 pp 3-11

POPKOV, V.I. and DEMIRCHYAN, K.S., Moscow

[Abstract] The scientific councils for the "Scientific Foundations of Electrophysics and Electrical Power Engineering" and "Comprehensive Problems in Power Engineering" of the USSR Academy of Sciences Department of Physics and Engineering Problems in Power Engineering have turned their attention to problems of power equipment reliability. This general survey deals with approaches to the resolution of such problems as the gathering, analysis and systematization of data on component defects in power equipment and setting up "feedback" with the manufacturing plants and planning organizations to improve equipment reliability. Such efforts on the part of designers, manufacturers and operating and repair organizations in analyzing faults in 300 MW turbogenerators during 1974-1977 reduced the specific fault rate by 20-25% and the downtime per failure by 35-40%. Since power equipment should operate for several hundreds of thousands of hours (20-30 years) and the majority of power components have guaranteed service lives of no more than 10^5 hours, an extremely difficult problem is the determination of the reliability of equipment past the 10^5 point. The present trend in the USSR Unified Power System towards increasing the number of shutdowns and starts, which in the case of turbogenerators of up 1,200 MW power can reach 7,500-10,000 cycles is noted. Other areas briefly treated are: MHD generator reliability and economy; nuclear power plant reliability and safety; the reliability of high-power high-voltage thyristor converters; the difficulties involved in scale modeling of power system reliability and the high cost of the requisite full-scale studies; the poor understanding of long term corrosion and erosion processes. The review concludes with arguments in favor of greater computerization of all aspects of power system management.

[23-8225]

THE REQUIREMENTS PLACED ON HIGH-POWER TURBOGENERATORS

Moscow IZVESTIYA AKADEMII NAUK SSSR: ENERGETIKA I TRANSPORT in Russian
No 6, Nov Dec 79 pp 12-19 manuscript received 1 Jun 79

MAMIKONYANTS, L.G., KHANAKOV, A.S. and CHISTIKOV, A.P., Moscow

[Abstract] Some of the requirements placed on the operational performance of turbogenerators, which are largely due to the shift from natural gas and liquid fuels to coal and nuclear power, are formulated on the basis of individual scientific and engineering data, rather than economic factors, taking both Soviet and Western experience into account. New turbogenerators not only meet the existing standards of GOST 182-74, GOST 533-76 and CEMA and IEC standards, but these standards are to be made more strict in certain areas: new two-pole turbogenerators should be designed to handle 7,500-10,000 shutdowns and run-ups over their service lives and the smaller figure in this case is permissible only for generators of more than 500 MW. The designs of fossil-fuel and nuclear electric power stations should be flexible enough to provide a rate of change in the active load of no less than 3 to 4% per minute during normal operation. Turbogenerators should also not limit the rate of acceptance of a reactive load, at least under emergency conditions. Another important requirement not covered by existing standards both in the USSR and abroad is the capability of generator operation at the nominal active power when consuming reactive power from the network; the corresponding requirement should be implemented in GOST 533-76 with a minimum being reactive power consumption at a power factor of 0.95 without a cutback in the active power. GOST 183-74 should place more stringent requirements on turbogenerators as regards sudden short circuits, both balanced and unbalanced, across the terminals of the stator winding at the nominal load and a voltage of 1.05 times the nominal, without any residual deformation in any of the machine components. Greater attention should be devoted to improving the vibration and noise characteristics of all generator components, where it is particularly important to reduce the noise level produced by the brush and contact assemblies of rotors and exciters. Changes should be made immediately in GOST 183-74 in the formulas for selecting a test voltage as a function of the nominal voltage of the exciter, based on French and U.S. experience and IEC recommendations. Improved vibration monitoring is called for along with an increase in the period between overhauls to 5 to 6 years. The primary form of excitation for new turbogenerators should become thyristor excitation systems, while for lower power levels (60-200 MW), parallel self-excitation without series transformers may be used. Brushless excitation of turbogenerators should become more widespread.

References: 7 Western.

[23-8225]

THE PHYSICAL PRINCIPLES OF RELIABILITY PREDICTION FOR HIGH-POWER GENERATORS DURING THEIR DESIGN STAGES

Moscow IZVESTIYA AKADEMII NAUK SSSR: ENERGETIKA I TRANSPORT in Russian No 6, Nov Dec 79 pp 20-30 manuscript received 13 Jun 79

BYKOV, V.M. and GLEBOV, I.A., Leningrad

[Abstract] A statistical approach to predicting the reliability of high-power generators is abandoned in favor of an approach based on the physical analysis of the mechanisms determining the strength of materials. An equation for the service life of such materials as austenitic steel and electrical engineering copper is derived, which takes into account the partially reversible nature of fracturing, where the following assumptions are made; 1. The failure of engineering materials occurs at the level of crystallites (or mosaic grains), the bonding energy between which is significantly greater than the bonding energy at the atomic level in the crystals; 2. The reversible nature of the fracture process is considered, and an expression is derived for the rate of bond restoration, where the acts of fracture and restoration of the bonds are equiprobable in an equilibrium state and the material is not fractured for an arbitrary length of time; 3. During the course of the mechanical and thermal loads, the nature of the structure and the chemical composition of the material do not change substantially, i.e., corrosion, changes in surface hardening, etc., are not considered. The results of fatigue tests of hollow copper and steel conductors show good agreement with the theoretically derived expression, even in the range of light loads. Good agreement is also found between theory and experimental data from domestic and foreign literature for the endurance limit plotted as a function of temperature. Measures taken to precisely measure the loading using resistive strain gauges are described and the study of the evolution of the microstructure of copper indicates that the fatigue fracture mechanism in the case of low and high cyclic loading is qualitatively the same. The service life equation is thus a good description of the damage accumulation processes and can be used to predict the reliability of components in a direct water cooling system for generators. Figures 2; references 22: 17 Russian; 5 Western.
[23-8225]

A PROCEDURE FOR CALCULATING THE ECONOMIC CHARACTERISTICS OF THE RELIABILITY OF THE STRUCTURAL COMPONENTS OF TURBOGENERATORS

Moscow IZVESTIYA AKADEMII NAVK SSSR: ENERGETIKA I TRANSPORT in Russian No 6, Nov-Dec 79 pp 31-37 manuscript received 19 Apr 78

BYKOV, V.M. and KOSMATOV, E.M., Leningrad

[Abstract] Cost factors affecting the failure operating probability of a turbogenerator structural component are analyzed for two cases: first, where the probability of failure-free operation of the component is specified, and second, in the general case where the probability is not specified and is based on an engineering and economic analysis. The analysis of the latter case considers the following costs: outlays for emergency back-up; annual outlays for emergency repairs; annual outlays for bringing a unit on line; the increase in annual expenditures in a power system due to changes in the cost of electric power generation during the operation of standby plants, as well as additional expenditures due to changes in the engineering and economic indicators, and generator parameters. An algorithm written in ALGOL-60 for the BESM-4 digital computer is applied to the calculation of the economic characteristics of the reliability of fluorocarbon polymer hoses for TVV turbogenerators. The change in the structure of the overall reduced expenditures as a function of the number of planned replacements over the service life of the generator is plotted graphically and the optimum values of the probability of failure-free operation and service life are presented in tabular form as a function of the number of replacements and an indicator related to the production cost of the component. While the specific formula derived for the sample calculation is justified only in the particular case treated here, and the determination of the production cost function for a component should be the subject of special studies for specific components, the proposed procedure makes it possible to economically justify design solutions in the planning stage, taking reliability indicators into account. Figures 3; references: 2 Russian. [23-8225]

USSR

UDC 621.315.1

SUPER HIGH AND ULTRAHIGH VOLTAGE ELECTRICAL POWER TRANSMISSION LINES

Moscow IZVESTIYA AKADEMII NAUK SSSR: ENERGETIKA I TRANSPORT in Russian No 6, Nov Dec 79 pp 72-83 manuscript received 27 Apr 79

TIKHODEYEV, N.N., Leningrad

[Abstract] The results of studies carried out by General Electric in the U.S. and Scientific Research Institute for Direct Current in the USSR on the breakdown voltage of an air gap using full-scale facilities are reported. Various insulator string and support configurations, and the effect the overvoltage pulse waveform and rise time were investigated. Since limiting switching overvoltages in ultrahigh voltage lines is the most effective way of further increasing the nominal voltage and easing the problem of open air insulation, the problem of choosing and testing insulator strings and equipment insulation is discussed in detail in light of such specific examples as the 1,150 KV Itat--Novokuznetsk 270 km test line. The evolution of line tower configurations in the USSR is treated along with problems of improving insulation materials such as transformer oil and the paper-oil insulation for power capacitors. The effect of the field intensity near high voltage lines on humans, especially when operating large equipment near them, are also discussed. It is found that one of the most effective ways of improving all of the engineering and economic parameters of ultrahigh voltage lines is the reduction of the mutual spacings between phases, which can be achieved through the use of V-shaped insulator strings and heavy limiting of the switching overvoltages. Figures 6; references 11: 9 Russian; 2 Western [23-8225]

USSR

UDC 621.313.322-81:621.3.017.22.001

MATHEMATICAL MODEL STUDY OF THE DISTRIBUTION OF EDDY CURRENTS IN THE REGION OF THE TRANSVERSE SLOTS OF A TURBOGENERATOR ROTOR IN THE CASE OF ASYMMETRIC WORKING CONDITIONS

Moscow IZVESTIYA AKADEMII NAVK SSSR: ENERGETIKA I TRANSPORT in Russian No 6, Nov Dec 79 pp 156-159 manuscript received 25 Dec 78

POPOV, V.V., Leningrad

[Abstract] The study of eddy current distribution is limited to the space enclosed between the planes of longitudinal and transverse symmetry of two adjacent slots, and the plane coinciding with the longitudinal edge of a

tooth. The permeability of the steel of the stator core is assumed to be infinitely large and its interior surface smooth. Only the eddy currents at the surface of the massive elements of the rotor are determined from the solutions of two - and three-dimensional boundary value problems which calculate the inverse synchronous magnetic field of the armature. The formulated boundary value problem was solved by modeling the eddy current distribution with RC networks. A two-dimensional R network was used for the rotor of a TVV-800-2 turbine generator and the distribution of the currents in the region of the transverse slot is plotted graphically, where the slot is 0.64 times the width of the large tooth. It is found that an effective measure to provide thermal relief for the transverse slot area is the installation of copper wedges covering the slots, mounting no less than three wedges for a practically uniform distribution of these losses in a tooth, two of which should be positioned close to the small edge of the transverse slot. The distribution of the eddy currents induced in the transverse slots by the inverse synchronous magnetic field of the armature can be found from the solution of the two-dimensional electromagnetic problem with an accuracy acceptable for practical engineering calculations (10-15%), where this formulation defines the distribution of the scalar magnetic potential only at the surface of the rotor. Figures 3; references 4 Russian.

[23-8225]

USSR

UDC 629.7.015.3.036:533.697

EXPERIMENTAL STUDY OF MODELS OF FLAT ASYMMETRIC NOZZLES UNDER CONDITIONS OF OVEREXPANSION

Kazan' IZVESTIYA VUZov: AVIATIONNAYA TEKHNIKA in Russian No 3, 1979
pp 23-27 manuscript received 7 Apr 77

GLAZKOV, V. M., DUGANOV, V. V., POLYAKOV, V. V. and PUZYREV, V. M.

[Abstract] The paper gives the results of investigations done on asymmetric flat nozzles under starting conditions with overexpansion of the nozzle jet. The experiments involved measurement of the pressure distribution on the nozzle walls and determination of the thrust characteristics. The experimental data are compared with calculations for a Mach number of 2 at the nozzle inlet. The thrust characteristics are given for configurations with profiled and straight walls, each with and without side cheeks. The lowest thrust losses were observed in a nozzle with profiled lower wall without side cheeks, which can be attributed to minimum overexpansion due to flow separation. Figures 4, references 5 Russian.
[35-6610]

USSR

UDC 621.652.001.24

DETERMINATION OF HYDRAULIC LOSSES IN A DISK PUMP

Kazan' IZVESTIYA VUZov: AVIATIONNAYA TEKHNIKA in Russian No 3, 1979 pp 39-43 manuscript received 13 Jun 78

MISYURA, V. I.

[Abstract] Formulas are derived for the actual head of a disk pump as the difference between an Euler equation for the theoretical head and the hydraulic losses in the flow section with consideration of head losses at the inlet to the impeller, losses as the liquid flows in the gaps between the rotating disks, and losses at the outlet. An analysis is made of the influence that geometric and hydrodynamic parameters of the impeller have on the losses in the disk pump. It is shown that the maximum head and efficiency of about 0.75 is achieved in a laminar disk pump with the following optimum parameters: relative radius (ratio of disk radius to hub radius) of 2.5-4 flow parameter $\lambda = 1.12-1.15$ ($\lambda = A/2 \cdot \sqrt{w/v}$, where A is the width of an individual gap, v is the coefficient of viscosity of the fluid, and w is the angular velocity of the impeller), and flow factor $\phi = 0.01-0.03$ ($\phi = Q/2 \pi r^2$, where Q is the fluid flowrate through the impeller, i is the number of working gaps, and r is the radius of the disks). Figures 3, references 6: 4 Russian, 2 Western.
[35-6610]

USSR

UDC 536.244:536.6.011.5

INVESTIGATION OF HEAT AND MASS EXCHANGE WHEN JETS INTERACT WITH A SUPERSONIC EFFERENT FLOW

Kazan' IZVESTIYA VUZov: AVIATIONNAYA TEKHNIKA in Russian No 3, 1979
pp 50-54 manuscript received 1 Oct 78

SHAYKHUTDINOV, Z. B., BAKIROV, F. G. and NADYRSHIN, A. YA.

[Abstract] The article gives some results of a comprehensive study of three-dimensional detached flows that arise with blow-in of a transverse jet from a hole in the wall of a channel into a supersonic efferent stream. The physical pattern of interaction between the blown in jet and the main supersonic flow was studied by measuring the static pressure distributions on the surface, obtaining "oil patterns" on the surface, and by taking Töpler schlieren photographs on the IAB-451 instrument. Heat exchange on the wall surface was experimentally studied in the region of three-dimensional boundary layer separation, and an investigation was made of the evolution of the blown in jet in the main flow, as well as the mixing characteristics. Empirical relations are given for determining the maximum coefficients of heat exchange in the zone of separation based on mathematical reduction of the experimental data. Figures 4, references 6 Russian. [35-6610]

USSR

UDC 621.182.614.72

FUEL IGNITION IN THE VIBRATION COMBUSTION MODE

Kazan' IZVESTIYA VUZov: AVIATIONNAYA TEKHNIKA in Russian No 3, 1979 pp 75-77 manuscript received 14 Apr 78

VEDIKHIN, S. V., GAFAROV, A. S., DOLGIKH, E. B. and KANDALANTSEVA, M. V.

[Abstract] Comparative experimental data are given on ignition of gaseous and liquid fuel in the vibration and turbulent combustion modes. The experiments were done in two types of pulsating combustion chambers. One was an injection-vibration burner 1.5 m long and 0.042 m in diameter. The chamber, mixer and gas-injection tube were coaxial and vertical, with the gas-injection apertures in the plane of the lower end of the mixer tube. A screen was installed above the combustion zone to increase the amplitude of pressure pulsations. The other chamber, known as a "quarter-wave" pulsation combustor, was a tube 1.5 m long and 0.064 m in diameter closed at one end. Premixed fuel was introduced into the chamber and burned at the closed end. Acoustic pressure inside the chamber was measured by a

pressure sensor installed at a distance of $1/3$ of the length from the closed end. The fuel was propane and solar oil. The composition of the combustion products was studied as dependent on the combustion mode: turbulent or vibration burning. It was found that the acoustic pulsations in the chamber in the vibration mode practically eliminate soot formation. Figures 2, references 5: 4 Russian, 1 Western.
[35-6610]

USSR

UDC 621.65:532.528

IMPROVING THE SUCTION CAPACITY OF VANE PUMPS

Kazan' IZVESTIYA VUZov: AVIATSIONNAYA TEKHNICA in Russian No 3, 1979 pp 86-88 manuscript received 12 Oct 78

GUROV, V. I. and SHESTAKOV, K. N.

[Abstract] A method is described for improving the suction capacity of vane pumps on high-speed aircraft by special devices consisting of cylindrical sleeves with blading around the outer diameter. The devices are installed between the impeller and suction line for the purpose of removing most of the "hot leaks" from the vane wheel, swirling them in the direction opposite to pump rotation, and mixing them with the main flow of the working fluid. The term "hot leaks" refers to the part of the working fluid that is higher in temperature than the main flow and runs from the high-pressure cavity behind the impeller to the cavity of the suction channel in front of the leading edges of the wheel vanes. The degree of equalization of temperature distribution depends on how the "hot leaks" are mixed with the main flow and the length of the mixing zone, which is determined by the length of the stationary sleeve of the device. The efficacy of the device has been experimentally confirmed for pumping of liquid oxygen at various temperatures. Figure 1, references 8 Russian.
[35-6610]

USSR

UDC 629.7.036.3

INVESTIGATION OF THE OPERATION OF A REVERSING DEVICE WITH FLAPS BEHIND THE NOZZLE TIP

Kazan' IZVESTIYA VUZov: AVIATSIONNAYA TEKHNIKA in Russian No 3, 1979 pp 119-122 manuscript received 2 Feb 78

TSYBIZOV, YU. I. and SALMANOVA, N. G.

[Abstract] Experimental studies are done on a reversing device for aircraft engines that has the reverse flaps located behind the outlet of the jet nozzle. The experiments were done to determine the way that reverse thrust is affected by the angle of the air scoops swiveled to the reverse flaps, the relative distance of the reverse flaps from the plane of the nozzle tip, and the gap between flaps along the nozzle axis. The results of the measurements show that if the angle of the scoop is close to the angle of tangency to the stream line, rarefaction occurs in the gap and for a short distance between the outer wall of the reverse flap and the scoop. In this case, a certain amount of air is sucked into the reversing jet from the outside. The jet then attaches to the scoop and takes the direction of the walls. On the inside a slight excess pressure acts on the other bounding stream line. A reduction in the angle of inclination of the reverse scoops throws part of the flow into the gap. This reduces the reverse thrust. Figures 2, references 4 Russian.
[35-6610]

USSR

UDC 532.529

MOTION OF GAS BUBBLES IN A LIQUID DUE TO COMPLEX VIBRATORY ACTION

Moscow MASHINOVEDENIYE in Russian, No 1, Jan Feb 80 pp 3-4 manuscript received 1 Feb 78; after revision, 30 Aug 78

GANIYEV, R.F., LAKIZA, V.D. and KULIK, V.V., Kiev

[Abstract] A study was made of controlling the movement of gas bubbles through a liquid such as fuel or molten metal in a weak gravitational field by combining ultrasonic vibrations (38-41 kHz) with either regular low-frequency (5-5000 Hz) sinusoidal vibrations or random (500-1000 Hz) noise vibrations. Adequate ultrasonic power for the experiment was produced by a piezoceramic (lead zirconate-titanate) radiator and adequate acceleration of regular vibrations were ensured by means of active bandpass filters. In

both cases the bubble localization and buildup process was found to become intensified, somewhat less with random than with regular low-frequency vibrations. It was furthermore found possible to control the direction of motion of gas bubbles vertically up or down by respectively raising or lowering the frequency of low-frequency (regular) vibrations. Figures 1; references 3 (Russian).
[32-2415]

USSR

UDC 533.6.013

VIBRATIONS OF A CYLINDER IN A VISCOUS FLUID

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 16, No 1, Jan 80 pp 62-67 manuscript received 18 Jul 77

SINYAVSKIY, V.F., FEDOTOVSKIY, V.S. and KUKHTIN, A.B., Institute of Physics and Power Engineering, Obninsk

[Abstract] An infinitely long cylinder is immersed in a viscous fluid filling a stationary cylindrical shell. Small harmonic transverse vibrations of this cylinder with an amplitude much smaller than the radial clearance are analyzed, assuming an attendant nonseparation flow of the fluid with the Reynolds number much higher than unity. The velocity field is found from the Laplace equation for the velocity potential, with the appropriate boundary conditions, whereupon the kinetic energy and the apparent mass are determined taking into account the existence of thin boundary layers at the surfaces. The problem of hydrodynamic damping is considered next, with not only frictional drag but also $-\frac{1}{2} \frac{dE}{dt}$ drag (u denoting the velocity and $\frac{dE}{dt}$ denoting the rate of energy dissipation) taken into account. Theoretical calculations supported by experimental data obtained with strain gauges and an oscillograph indicate a strong dependence of both the apparent mass and the damping coefficient on the ratio of radii and on the parameter $\frac{\sqrt{2\nu/w}}{a}$ (ν denoting the kinematic viscosity of the fluid, a denoting the radius of the inner cylinder, w denoting the frequency of vibrations). Figures 4; references 6: 4 Russian, 2 Western.
[37-2415]

USSR

UDC 532.595

ANALYSIS OF PROBLEMS OF NONLINEAR DYNAMICS OF A TANK WITH LIQUID BY A VARIATIONAL METHOD

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 16, No 1, Jan 80 pp 99-105
manuscript received 19 Oct 78

LIMARCHENKO, O.S., Institute of Mechanics, Academy of Sciences of the Ukrainian SSR, Kiev

[Abstract] The author considers nonlinear displacements of a tank with liquid, and the free surface of the latter, due to action of a pulse force on its walls. The dynamic behavior of such a system is analyzed by a modification of the Kantorovich method which takes into account the kinematic boundary condition at the free surface. This kinematic constraint couples the perturbation field on the free surface and the velocity potential in the liquid partially filling a forward moving straight cylinder of an arbitrary cross section. The problem is analyzed in an orthogonal system of coordinates fixed to the tank, according to a variational method in the Lagrange formulation involving hyperbolic functions. A specific solution is obtained for a tank of rectangular cross section with a transverse force acting on its lateral walls. One conclusion drawn from the results is that a tank partially filled with liquid is more compliant and faster accelerated by a smaller force than a tank with solid content. The shorter the duration of the force is, the more intensive will be the subsequent agitation of the free surface. Experimental studies have confirmed, furthermore, that the nonlinear dynamic theory more closely agrees with reality, reflecting an asymmetric wave profile on the free surface with the height of the crest larger than the depth of the trough. Figures 4; references 14 Russian.
[37-2415]

USSR

UDC 534.2:536.252

EFFECT OF VIBRATIONAL ACCELERATION OF CONVECTIVE HEAT TRANSFER

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 16, No 1, Jan 80 pp 128-131
manuscript received 9 Mar 78

DOBKIN, F.S., Institute of Mechanics, KOBASKO, N.I., Institute of Engineering Thermophysics, Academy of Sciences of the Ukrainian SSR, Kiev

[Abstract] An experimental study was made to determine the effect of vibrational acceleration on convective heat transfer. The test apparatus consisted of a tank with water at 25°C standing on an electrodynamic vibrator

and a Dewar flask with melting ice. A spherical steel bulb with one thermocouple mounted on its surface and two thermocouples inserted into a deep radial hole served as a probe. Measuring instruments included a set of three potentiometers, a frequency meter and an accelerometer. The bulb was heated in a thermostat to 100°C and then immersed in the water. Each series of such tests was begun and ended without vibrations of the water tank, with various modes of vibrations in the vertical plane between. Bulb cooling and water heating data, assuming regular modes of heat transfer, were evaluated with aid of a computer so as to yield the heat transfer characteristics in terms of cooling rate, Biot number, Nusselt and Rayleigh numbers in a power-law relation, temperature differential and mean temperature. The results indicate that the heat transfer intensifies with increasing vibrational acceleration and that changing the amplitude of vibrations at a fixed frequency is more effective than changing the frequency while maintaining the same amplitude. Figures 3; tables 1; references 7: 4 Russian, 3 Western.

[37-2415]

USSR

UDC 621.382.52

FREQUENCY CHARACTERISTICS OF GERMANIUM PHOTOTRANSISTORS IN THE REGION OF 200-10,000 Hz

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST' in Russian No 10, 1979
pp 56-57 manuscript received 20 Jan 78

STEPANOVA, G. A., BARANOV, V. A., GIMATUTDINOVA, G. I. and YUMAKULOVA, F. F.

[Abstract] The article gives the results of studies of FTG-3 and FTG-5 germanium phototransistors. A type A light source was used with color temperature of 2850 K, producing an illuminance of 50 lx in the plane of the sensitive area. A mechanical modulator was used to vary the pulse repetition rate of the light flux from 200 to 10,000 Hz in 50 Hz steps. For each modulation frequency the corresponding resonant frequency was set in a U2-4 amplifier, and the amplitude of the signal and noise voltage was determined. Analytical formulas were derived from the experimental results by the method of least squares. It is found that the threshold sensitivity of the FTG-3 and FTG-5 phototransistors is quite appreciably dependent on the frequency of light modulation with little change in integral sensitivity. Signal modulation with frequency exceeding 3000 Hz is optimum in systems for detecting weak signals. Nearly constant threshold sensitivity in the 3,000-10,000 Hz range makes these devices suitable for tracking weak frequency-variable signals. Figures 3, references 3 Russian.
[33-6610]

USSR

UDC 535.312

CALCULATION OF A CORNER REFLECTOR

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST' in Russian No 11, 1979
pp 56-57 manuscript received 3 Sep 78

SIVTSOV, G. P.

[Abstract] The author considers the problem of calculating the position and angle of a flat dihedral optical system with respect to predetermined triplets of orthogonal unit vectors in the space of objects and images. The edge of the corner reflector is determined by a unit vector of invariant direction which is found as an eigenvector of the matrix of the dihedral. A formula for the dihedral angle is found by using the invariance of the spur of the matrix. Quantities are introduced that can be treated as cosines of angles of incidence of rays on the mirrors of the dihedral, and that uniquely determine the position of each component of the corner reflector. Figures 1, references 2 Russian.
[34-6610]

USSR

UDC 621.378.333+535.417.2

INFLUENCE OF HEATING ON THE REFLECTANCE OF ALUMINUM COATINGS IN THE VACUUM
ULTRAVIOLET REGION OF THE SPECTRUM

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST' in Russian No 11, 1979
pp 14-15 manuscript received 17 Nov 77

DYMSHITS, YU. I., KOROBITSYN, V. A. and METEL'NIKOV A. A.

[Abstract] An investigation is made of the influence that prolonged heating has on the reflectance of $Al+MgF_2$ coatings to determine the feasibility of using them as the mirrors in vacuum UV laser cavities. The aluminum coating was vacuum-sputtered on a magnesium fluoride backing, and a magnesium fluoride layer was then applied with optical thickness of half a wavelength at $\lambda = 160-170$ nm. The optical characteristics of the mirrors were studied on a VMR-2 vacuum photometer. In the wavelength region of 160-170 nm, reflectance was 80-83% and transmission was 4-5%. Reflectance during heating was measured on several wavelengths close to the working wavelengths of excimer lasers. Measurements were made from room temperature to 600 K. It is found that prolonged heating at the temperature of recrystallization of aluminum leads to destruction of the film and irreversible deterioration of reflectance. The threshold power density of continuous laser emission is evaluated, and it is found that preheating the mirrors at low temperatures can improve the stability of the coatings. Figures 2, references 6: 5 Russian, 1 Western.
[34-6610]

USSR

UDC 621.391.837.1:/621.374.22/

INFLUENCE THAT PARAMETERS OF RC FILTERS HAVE ON THE RESOLUTION OF A
PHOTOELECTRIC SCANNING SYSTEM

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST' in Russian No 11, 1979
pp 16-18 manuscript received 28 Dec 78

LUSTBERG, E. A. and GORBACH, T. A.

[Abstract] The authors consider the problem of resolving two objects located close together when the signal amplitude is of the order of the noises of the photoelectric scanning system. An RC filter is used as a threshold device that passes only the signal polarity of maximum absolute magnitude. The input optical signals are from two point sources that may have different luminous intensity, but produce the same illuminances in the plane of the entrance pupil. It is found that an RC filter with a single

differentiating circuit gives better resolution than one with two differentiating circuits if the signal-to-noise ratio at the output of these filters differs by the same amount from the signal-to-noise ratio of a filter that is optimum with respect to internal noises. The use of filters with a single differentiating link that give a signal-to-noise ratio close to optimum enables detection of sources with closer angular spacing than when filters are used with non-optimum signal-to-noise ratio at the output. Figures 4, references 3 Russian.
[34-6610]

USSR

UDC 535.31.772:621.373.325

GEOMETRIC-OPTICS CALCULATION OF LASER BEAM DISTORTIONS WITH REFRACTION BY SPHERICAL SURFACES

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST' in Russian No 11, 1979 pp 19-21 manuscript received 14 Nov 78

TSIBULYA, A. B. and CHERTOV, V. G.

[Abstract] A geometric-optics approximation is proposed for calculating the path of a laser beam obliquely incident on a diffracting spherical surface. An example of application of the technique shows that it can be used to estimate distortions of laser beams in real optical systems. Expressions are derived that generalize H. Kogelnik's formulas to a system with different indices of refraction in the space of objects and images. Figures 4, references 5: 3 Russian, 2 Western.
[34-6610]

USSR

UDC 621.378.325

MODEL OF A RING RUBY LASER WITH INDUCED MODE LOCKING

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST' in Russian No 11, 1979 pp 23-25 manuscript received 4 Oct 78

ZAPOROZHCHENKO, V. A., ZAPOROZHCHENKO, R. G., KACHINSKIY, A. V., KAMACH, YU. E., KOZLOVSKIY, YE. N., OVCHINNIKOV, V. M., TYLETS, N. A., POPOV, P. A., PIVOVARCHIK, V. F. and SHAKHLAY, I. P.

[Abstract] A ring laser with induced mode locking is proposed with a cavity designed so that the radiation passes through the modulator twice on a complete circuit, and the interval between passages can be regulated.

The proposed system gives the following characteristics of the rf pulse across the modulator: amplitude of 2-7 kV, duration 10-20 us, a cycle frequency 90 MHz, carrier frequency instability 10^{-4} or less, slope of the top of the rf pulse 0.1 kV/us or less. A detailed investigation was made of the laser characteristics under conditions when a pulse train was coupled out of the cavity: time and spectral characteristics, efficiency of lasing on the second harmonic, dependence of output emission on the mismatch between the frequency of intermode beats and the modulation frequency. The results show that the laser can produce ultrashort pulses (duration of $2 \cdot 10^{-11}$ s) with peak intensity of up to $5 \cdot 10^9$ W/cm². Figures 4, references 9 Russian.
[34-6610]

USSR

UDC 51.001.57

CALCULATION OF THE CHARACTERISTICS OF CARBON DIOXIDE TEA PHOTOIONIZATION LASERS

Leningrad IZVESTIYA VUZov: PRIBOROSTROYENIYE in Russian No 10, 1979 pp 65-70 manuscript received 6 Sep 78

AVER'YANOV, N. YE., BALOSHIN, YU. A., GERKE, M. N. DERNYATIN, A. I. and KHURGIN, YA. B., Leningrad Institute of Precision Mechanics and Optics

[Abstract] A mathematical model is proposed for studying the characteristics of a carbon dioxide photoionization laser with pressures of the active mixture of the order of one atmosphere. The kinetics of the CO₂ molecules is described in terms of population of the group of lower vibrational levels. The part played by N₂ molecules in the general system of kinetic equations is accounted for by a harmonic oscillator model with Boltzmann population of vibrational levels and the corresponding vibrational temperature. A diagram is given of the fundamental kinetic processes in the proposed model for a TEA laser. The results of calculations are compared with a previously proposed model and with experimental data for a carbon dioxide TEA photoionization laser using preionization by ultraviolet radiation and operating in the semi-selfmaintained discharge mode. The active mixture was CO₂:N₂:He=1:1:8. It was found that optimum mixtures for maximum power are those with ratios of CO₂:N₂:He=5:45:50, 10:40:50 and 5:55:40. The helium molecules supply most of the photoelectrons, and the additives give a UV spectrum that is optimum for photoionization of He. The CO₂ is the lasing molecule, but absorbs UV radiation, and therefore the optimum CO₂ concentration is low. The influence that dissociation of CO₂ molecules has on the laser depends on the electron concentration in the main discharge. Any model that reliably describes laser characteristics must take account of dissociation of the lasing molecules by means of some factor that shows how many molecules are dissociated by UV radiation, although the dissociation by electron impact can be disregarded. Figures 3, references 8: 2 Russian, 6 Western.

[26-6610]

ON USING A MIRROR SYSTEM IN LIGHT-VALUE PROJECTORS

Leningrad IZVESTIYA VUZov: PRIBOROSTROYENIYE in Russian No 10, 1979
pp 75-77 manuscript received 17 Aug 78

KHVALOVSKIY, V. V. and FEDOFOV, YU. V., Leningrad Institute of Precision Mechanics and Optics

[Abstract] Light-valve projectors are used for reproducing a phase-optical recording in the form of surface relief on a transparent material by the dark-field method. In its usual form, the light-valve projector consists of a light source, an illuminating system, a lens projection system with a visualizing iris (opaque shade) in the frequency plane, and a screen. The projection lens system involves energy losses due to transmission and reflection, and increases the background light level on the screens. The authors propose a two-mirror axisymmetric projection system that eliminates these difficulties. A large concave mirror receives only light that has been diffracted by the phase object, and a smaller concentric concave mirror serves both as an image-forming component of the optical system and as a visualizing iris. Major parameters are given for a number of such systems as calculated by V. N. Churilovskiy's formulas (see V. N. Churilovskiy, "Teoriya khromatizma i aberratsiy tret'yego poryadka" (Theory of Chromatism and Third-Order Aberrations), Leningrad, Mashinostroyeniye, 1968). It is shown that for a fixed focal length a 5x magnification is critical, since the image coincides with the vertex of the first mirror. Transverse aberration for such a system does not exceed 0.01 mm. Figures 2, references 2 Russian.

[26-6610]

DESIGN AND CHARACTERISTICS OF A MICROTRON ACCELERATOR FOR THE 5-cm BAND

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 6, Nov Dec 79 pp 30-32
manuscript received 21 Jun 78

ZAKHAROV, M. A., MELEKHIN, V. N. and SUKHACHEV, V. YA., Institute of Physics Problems, Academy of Sciences USSR, Moscow

[Abstract] The 10-cm wave band is ordinarily used for electron acceleration in microtrons, the rf pulse power of the sources being about 2 MW, producing a bremsstrahlung intensity of about 2000 R/min at an energy of

10 MeV. Small microtrons in the 3-cm band utilize a supply with pulse power of hundreds of kW and produce bremsstrahlung with intensity of about 5 R/min. This paper describes a 5-cm microtron with intermediate wavelength and other parameters. The 5-cm microtron is superior to larger and smaller units with regard to conditions of injection and focusing of particles, and also the width of the available range of accelerated electron energies. It is also possible to reduce the magnet diameter as compared with the 10-cm unit for the same particle energy. These advantages were verified on a 14-orbit microtron with magnet 680 mm in diameter, 260 mm high and 62 mm in the gap between poles. The inhomogeneity of the field does not exceed 0.2% throughout the working volume. At an electron energy of 10 MeV, the pulse current is 10 mA for an average power of 100 W in the electron beam. The authors thank V. A. Afanas'yev and S. P. Kapitsa for interest in the work and discussion of the results. Figures 2, references 5 Russian.
[27-6610]

USSR

UDC 621.822.6.001.24:62-192

INCREASING THE ACCURACY OF SCANNING SYSTEMS IN MECHANISMS OF ELECTRONIC EQUIPMENT

Moscow IZMERITEL'NAYA TEKHNIKA in Russian No 1, 1980 pp 16-17

SOKOLOV, A. I., NEKRASOV, M. I. and GAN, K. G.

[Abstract] The coefficients contained in the known formula for determining the life of ball bearings were determined. The proposed method was checked on instrument radial single-row bearings with shaft diameters of 3-25 mm and with variation of the rolling angles within the range of $\pm 1-5^\circ$ and variation of rolling frequencies of 5-20 Hz. The experiments show that the operating life of a bearing in the atmosphere and in a vacuum depends on the transverse dimensions of the contact spots on the inner races with the most heavily loaded balls during reciprocating motion of the balls. The redominant destructive process in a vacuum is seizure. Microseizure and abrasive wear of the working sections of the races become the predominant process with a reduction in loading of an increase in rolling angle to a value which excludes overlapping of contact spots. Contact stresses should be reduced to 1,000 MPa, ball bearings with the largest possible number of rolling bodies of small diameter should be used, vacuum lubricants with high adhesive capability to bearing steels and the outer race of the bearing should be used as the moving race if possible in load-bearing components to increase the precision and life of ball bearings operating in a vacuum. References 3: 2 Russian, 1 Western.

USSR

UDC 536.21:62-434.1.001

CALCULATION OF THE TEMPERATURE FIELD IN A CYLINDRICAL, HEAT-EMITTING ROD FOR BOUNDARY CONDITIONS OF THE THIRD WHICH VARY ABOUT THE PERIMETER

Moscow IZVESTIYA AKADEMII NAUK SSSR: ENERGETIKA I TRANSPORT in Russian No 6, Nov Dec 79 pp 165-169 manuscript received 27 Jan 77, after revision 19 Mar 79

GALIN, N.M.

[Abstract] A continuous cylindrical rod with internal heat sources is considered for boundary conditions of the third kind where the heat transfer coefficient changes along the perimeter. The problem of computing the temperature field in a damaged nuclear fuel rod reduces to this formulation. A method developed by V. G. Galerkin and refined by Yu. I. Grosberg in 1952 is used to derive an approximate solution for the problem, where the temperature field is written in the form of a converging series. The

procedure does not require that the coordinate function satisfy boundary conditions, and is therefore applicable to regions with a complex shape. Expressions estimating the error are derived and a sample calculation indicates a maximum error of 3.8% for the specific case considered. Figures 1; references: 9 Russian.
[23-8225]

USSR

UDC 621.438-253:536.2:539.4

CALCULATION OF THE THERMAL AND STRESSED STATES OF RADIAL-AXIAL TURBINE RUNNERS

Kazan' IZVESTIYA VUZov: AVIATIONNAYA TEKHNIKA in Russian No 3, 1979
manuscript received 13 Oct 78

STRUNKIN, V. A., SAGADEYEV, R. G. and KADYSHEV, V. G.

[Abstract] The article gives the major principles and peculiarities of an algorithm for comprehensive calculation of the thermal and stress-strain states of radial-axial turbine runners, and also a program for realization of the proposed algorithm, developed at the Turbomachine Department of Kazan' Aviation Institute. The impeller is treated as an object comprised of two connected elements: a disk of arbitrary profile, and radial blades of variable thickness with arbitrary planform. Calculation is based on the finite element method. Problems of steady-state thermal conduction and thermoelasticity are solved in the two-dimensional approximation. The program is written in FORTRAN for YeS EVM computers. An example is given of calculation of the heat-stressed state of a runner in a small gas turbine engine. Figures 4, references 7 Russian.
[35-6610]

USSR

UDC 531.44:530.096

CALCULATING THE TEMPERATURE OF A FRICTION SURFACE AND THE TEMPERATURE FIELDS WITHIN THE CONTACT ZONE OF HIGH-SPEED FRICTION

Moscow MASHINOVEDENIYE in Russian, No 1, Jan Feb 80 pp 91-93 manuscript received 16 Jan 79

BALAKIN, V.A., Gomel

[Abstract] The temperature of the friction surface and the temperature field within the contact zone are determined for a high-speed sliding bearing with a characteristically low overlap factor. The calculations are based on the

Fourier equation of transient heat conduction, including the appropriate error function, with the friction couple regarded first as semiinfinitely large (at $N_{Fo} < 0.2$) and then as infinitely large (at $N_{Fo} > 0.3$) plates of uniform thickness heated linearly on one side and thermally insulated on the other. An analysis of the transient heating curves for a typical shoe made of St 10 steel and examination of its sliding track indicate formation of a continuous adhesive layer of steel with traces of fusion on the journal surface at sliding velocities of 250-350 m/s after correspondingly shorter times. Figures 3; references 12: 11 Western, 1 Western.
[32-2415]

USSR

UDC 534.014.5:621-233.21

FORCED VIBRATIONS OF A DYNAMIC SYSTEM WITH GAS BEARINGS IN ELASTIC ABSORBERS AND UNIVERSAL JOINTS

Moscow MASHINOVEDENIYE in Russian, No 1, Jan Feb 80 pp 94-98 manuscript received 29 Aug 78; after revision, 5 Mar 79

SAKHAROV, V.M. and KAZAKOV, N.P., Moscow

[Abstract] Dynamic rotating systems with gas bearings are considered which include universal joints to ensure coaxiality of the rotor and external elastic absorbers to attenuate forced vibrations of the rotor within the operating speed range. These features complicate the design of bearings and the analysis of forced vibrations. Here the analysis is based on the Lagrange equation of motion and force balance. The resonance diagrams calculated for typical numerical values of rotor-bearing system parameters indicate that with elastic absorbers one can attain almost any damping characteristic suitable for a given system and that by combining such absorbers with a universal joint one can extend the operating speed range even in the case of thin-film lubrication and rotor imbalance. Figures 4; references 4 Russian.
[32-2415]

USSR

UDC 533.6.013.42

DEFORMATION OF A MULTILAYERED SPHERICAL SHELL BY A WEAK SHOCK WAVE

Kiev PRIKLADNAYA MEKhanika in Russian Vol 15(25), No 12, Dec 79 pp 28-35
manuscript received 23 Oct 78

BABAYEV, A. E., KUBENKO, V. D. and KURBAKOV, V. G., Institute of Mechanics,
Academy of Sciences UkrSSR, Kiev

[Abstract] An exact solution is found for the problem of interaction of a weak plane shock wave with a multilayered spherical shell, and numerical results are given. It is assumed that the shell is in an infinite gaseous or liquid ambient medium, where perturbed motion is treated in the acoustic formulation. The thickness of the shell is small enough so that the hypothesis of undeformed normals is applicable to the entire stack of layers treated as a unit. The layers are isotropic and symmetric relative to the middle surface. At time zero, a weak plane shock wave sets up unsteady oscillations of the shell and produces a field of radiated and reflected waves in the ambient medium. The problem is solved by series expansion in terms of orthogonal functions for normal modes, and by using a Laplace transform with respect to time. Passage to the region of originals is based on residue theory. Diagrams of the normal modes of the shell are given and the nature of the change in flexure with time is demonstrated. Stress distribution in the layers of the shell can be determined comparatively readily from the results of the analysis. Figures 3, references 17 Russian.
[33-6610]

USSR

UDC 539.3

ON SOLVING PROBLEMS OF STATICS OF ANISOTROPIC SHELLS OF VARIABLE THICKNESS
WEAKENED BY OPENINGS

Kiev PRIKLADNAYA MEKhanika in Russian Vol 15(25), No 12, Dec 79 pp 51-58
manuscript received 30 Jan 79

SHNERENKO, K. I., Institute of Mechanics, Academy of Sciences UkrSSR, Kiev

[Abstract] A method is proposed for solving problems of determining the stress distribution around holes in multilayered orthotropic shells of shear-compliant composition material of variable thickness. It is shown that determination of the stress-strain state in the shell involves the construction of generalized variables that satisfy a system of differential equations of tenth order, conditions of damping of the perturbed stressed state far from the holes, and boundary conditions on the contour. A variational formulation is given for cylindrical, spherical and ellipsoidal shells with

consideration of the deformation of transverse shearing and anisotropy of the properties of the material. A comparison of the results given by the variational method for anisotropic plates with the exact solution, and for cylindrical shells with experimental data shows that the calculated data are exact enough for practical purposes. The results can be used in designing components of thin-walled structures with predetermined strength properties. References 6 Russian.
[33-6610]

USSR

UDC 539.3

A UNIFORMLY STRESSED CYLINDRICAL SHELL UNDER THE ACTION OF LOCALLY APPLIED LONGITUDINAL FORCES

Kiev PRIKLADNAYA MEKhanika in Russian Vol 15(25), No 12, Dec 79 pp 59-64
manuscript received 26 Dec 78

MAKSIMENKO, V. P., Institute of Mechanics, Academy of Sciences UkrSSR, Kiev

[Abstract] An analysis is made of cylindrical shells reinforced by longitudinal ribs, and by rings around the ends. It is required that the stresses in the shell, ribs and rings (which vary in height) shall not exceed permissible maximum values. For each intermediate solution the calculation gives the heights of the variable elements, the maximum stresses, the maximum flexure of the entire structure, and its weight, and also tells which of the longitudinal ribs bear stresses so small that they can be removed without impairment of strength. Results are given for a shell loaded by four longitudinal cyclically symmetric concentrated forces. References 5 Russian.
[33-6610]

USSR

UDC 539.3

INVESTIGATION OF THE STABILITY OF IMPERFECT RIBBED CYLINDRICAL SHELLS

Kiev PRIKLADNAYA MEKhanika in Russian Vol 15(25), No 12, Dec 79 pp 70-76
manuscript received 30 May 78

ETOKOV, V. I., Institute of Mechanics, Academy of Sciences UkrSSR, Kiev

[Abstract] In a previous paper [see SOPROTVLENIYE MATERIALOV I TEORIYA SOORUZHENIY, No 24, 1974, pp 7-16], the author and I. Ya. Amiro proposed a new method for solving the problem of stability of a cylindrical shell of imperfect shape by combining traditional methods of calculating the

subcritical state with a geometric method that describes the rhombic buckling of a shell that is usually observed in experiments. The conditions of transition from the subcritical state to the rhombic shape conform to an energy principle that requires that the energies of deformation of these equilibrium shapes must be equal at the instant of buckling for identical values of approach of the ends of the shell. This approach has been applied to investigation of the stability of smooth isotropic and orthotropic shells, and in this paper it is extended to the case of ribbed cylindrical shells of imperfect shape that may have a small number of reinforcing elements. Figure 1, references 5 Russian.
[33-6610]

USSR

UDC 534.22

INFLUENCE THAT A CYLINDRICAL SHELL OF COMPOSITE MATERIAL HAS ON THE ACOUSTIC FIELD OF A TRANSDUCER

Kiev PRIKLADNAYA MEKhanika in Russian Vol 15(25), No 12, Dec 79 pp 110-114
manuscript received 20 May 78

SAVIN, V. G., CHERNUSHENKO, I. I. and SHUL'GA, N. A., Institute of Mechanics, Academy of Sciences UkrSSR, Kiev, and Kiev Economic Trade Institute

[Abstract] An analysis is made of the way that protective cylinders of composite materials distort the signals transmitted or received by enclosed acoustic transducers. The influence of the finite dimensions of the thin-walled container and transducer are disregarded, and the problem is formulated in terms of two acoustic media separated by an infinitely long laminar cylindrical shell of composite material. The shell encloses a coaxial cylinder. The oscillations of the laminar shell are described by a theory of the S. P. Timoshenko type. It is shown that a signal on a given frequency can be considerably increased by moving the transducer radially relative to the enclosure. Figures 2, references 4 Russian.
[33-6610]

USSR

UDC 539.3

NONLINEAR OSCILLATIONS OF A CYLINDRICAL PANEL CONNECTED TO AN ELASTIC BASE

Kiev PRIKLADNAYA MEKhanika in Russian Vol 15(25), No 12, Dec 79 pp 114-117
manuscript received 8 Jun 77

IL'INA, A. M. and KUZEMKO, A. M., Zaporozh'ye Machine Building Institute

[Abstract] The paper gives the results of a study of normal nonlinear oscillations of a thin-walled cylindrical panel connected to an elastic base that is modeled by a system of weightless spring columns that are not interconnected. Movement of the panel is described by nonlinear equations for nearly flat shells in mixed form, and the motion of the base is described by a wave equation. The frequency of the oscillations is determined as a function of amplitude for different base rigidities and densities when all edges of the panel are freely supported. Figures 2, references 2 Russian.
[33-6610]

USSR

UDC 534.2:532

OSCILLATIONS OF A CYLINDRICAL BODY CLOSE TO A FLAT BOUNDARY

Kiev PRIKLADNAYA MEKhanika in Russian Vol 15(25), No 12, Dec 79 pp 117-120
manuscript received 21 Jun 78

RYABUKHA, YU. N., Kiev

[Abstract] A solution is found for the plane problem of forced oscillations of an infinite circular cylinder in an acoustic medium close to a rigid screen. The diffraction field is found in the vicinity of the cylinder, and also its dependence on wavelength and distance to the rigid screen. The method of images is used to satisfy the condition on the boundary. The problem reduces to solution of an infinite system of algebraic equations, which is converted to a system of normal type. The principles are determined that govern the arising of resonances at the point on a flat boundary closest to the cylinder. Figures 5, references 7 Russian.
[33-6610]

USSR

UDC 539.3:534.1

FREQUENCY SPECTRUM OF VIBRATION MODES IN LONG CYLINDERS

Kiev PRIKLADNAYA MEKhanika in Russian Vol 16, No 1, Jan 80 pp 3-7 manuscript received 11 Jan 79

GRINCHENKO, V. T. and KOMISSAROVA, G.L., Institute of Mechanics, Academy of Sciences of the Ukrainian SSR

[Abstract] A long isotropic cylinder is considered and the frequency spectrum of its vibrations antisymmetric with respect to the median plane is analyzed. The boundary-value problem for normal stresses under a load periodically varying in time is solved assuming a zero Poisson ratio, which eliminates coupling of mechanical systems but retains all characteristics of the spectrum associated with expansion and shear waves. Two kinds of modes are found to occur, hyperbolic modes, and Lamb modes, their numbers depending on the cylinder proportions. Modes of both kinds can coexist at certain frequencies, forming degenerate modes, or transition from one kind to the other takes place within intermediate ranges of the spectrum. Figures 5; references 11: 5 Russian, 6 Western.
[37-2415]

USSR

UDC 534.2:534

VIBRATING CYLINDER INSIDE A SHELL NEAR THE BOUNDARY OF AN ACOUSTIC HALF-SPACE

Kiev PRIKLADNAYA MEKhanika in Russian Vol 16, No 1, Jan 80 pp 8-12 manuscript received 12 Oct 78

RYABUKHA, YU.N., Kiev

[Abstract] The author considers a thin infinitely long orthotropic elastic cylindrical shell and forced vibrations within its acoustic half-space due to a cylindrical sound radiator inside. The acoustic medium between both cylinders has a wave impedance generally different from that of the medium outside the shell. The problem is solved here assuming both cylinders to be coaxial. First the scalar Helmholtz field equations are solved for appropriate boundary conditions and then the linear differential equations of motion for the shell. Numerical results have been obtained for a shell made of ASTT(b)-C₂-0 fiber glass plastic with a polymaleinate binder, water inside and outside, and a flat perfectly rigid acoustic boundary outside the shell. The acoustic pressure modulus was calculated as a function of the distance from the shell to this boundary, at three critical points around the shell circumference so as to establish its angular distribution. Figures 4; references 9 Russian.
[37-2415]

USSR

UDC 539.3

STABILITY OF A CYLINDRICAL SHELL CARRYING AN ARRAY OF LINEARLY DISTRIBUTED MASSES UNDER A PULSE LOAD

Kiev PRIKLADNAYA MEKhanika in Russian Vol 16, No 1, Jan 80 pp 19-25 manuscript received 21 Nov 77

ANDREYEV, L. V., DUBOVIK, O.M., DYSHLO, A.L. and PAVLENKO, I.D., Dnepropetrovsk State University

[Abstract] Dynamic buckling of a closed circular cylindrical shell on hinge supports due to a pulse of uniform external pressure is considered when this shell carries an array of masses uniformly distributed over the circumference. Not only normal inertial forces are taken into account, but also the discrete spacing of stringers. The problem is formulated according to the theory of shallow shells, linearized, and reduced to a system of ordinary differential equations in time and generalized space coordinates. Numerical integration has been performed on an M-222 high-speed digital computer by Runge-Kutta method, for a shell (radius 72 mm, length 144 mm, thickness 0.25 mm) carrying various numbers of stringers and a rectangular pressure pulse of a duration ten times shorter than the period of axisymmetric vibrations of the smooth shell. The results indicate instability modes and critical pressure pulses. They also indicate limitations of the engineering theory of orthotropic design, the error of the latter increasing infinitely as the number of stringers decreases toward zero. Figures 5; references 2 Russian. [37-2415]

USSR

UDC 539.374

PLASTIC BUCKLING OF CYLINDRICAL SHELLS UNDER COMPLEX LOADING

Kiev PRIKLADNAYA MEKhanika in Russian Vol 16, No 1, Jan 80 pp 26-31 manuscript received 24 Nov 77

GUDRAMOVICH, V.S., GAYDUCHENKO, A.P., DEMESHKO, M.F. and KONOVALENKOV, V.S. Institute of Mechanics, Academy of Sciences of the Ukrainian SSR, Dnepropetrovsk branch

[Abstract] An experimental and theoretical study was made to determine the effect of complex loading paths, curvilinear in the plane of acting forces, on buckling of cylindrical shells under axial compression and external pressure. The experiment tested 27 shells, tubes made of AMG-6M aluminum-magnesium alloy, with an outside diameter of 0.2 m, a wall thickness of 0.01

m and a 1.5 length-to-radius ratio. The shells were loaded along various complex paths by successive increments of axial compression and external pressure, also for reference by "pure" compression and "pure" pressure. The theoretical analysis was based on the theory of flow with translational hardening, taking into account strain anisotropy and spreading of the surface material under load in the process of plastic deformation. The results show close agreement between measured and calculated critical forces. Figures 4; tables 2; references 9: 8 Russian, 1 Western.
[37-2415]

USSR

UDC 539.3

REACTION OF A CYLINDRICAL SANDWICH SHELL TO A MOVING LOAD

Kiev PRIKLADNAYA MEKhanika in Russian Vol 16, No 1, Jan 80 pp 32-39 manuscript received 20 Oct 77

POZHUYEV, V.I., Dnepropetrovsk Institute of Mining

[Abstract] A normal load is considered moving at a constant velocity axisymmetrically along a cylindrical shell consisting of three layers, two sheaths with a filler between them, the velocity of the load being lower than the velocity of shear waves propagating through the center layer. The equations of motion are solved exactly, motion of the filler being described by Lamé's equations in cylindrical coordinates and the solution being expressed in a moving system of coordinates, with the thickness of both outer layers assumed to be small. Subsequent application of Hooke's law to the components of stress yields a system of algebraic equations for the boundary conditions with either a sliding or a rigid contact. The reaction of a finite cylinder to various moving loads such as a concentrated annular force or a uniformly distributed or exponentially tapering pressure is found by superposition, using the Fourier integral representation of the load and the known solution for a sinusoidal or cosinusoidal load. Special cases are the extremes of an empty center layer and a perfectly rigid filler. Numerical results obtained for typical shells indicate critical load velocities and the performance at subcritical velocities. Figures 3; references 8 Russian.
[37-2415]

USSR

UDC 539.3

FREE VIBRATIONS OF A REINFORCED CONICAL SHELL WITH A MASS ATTACHED THROUGH SPRINGS

Kiev PRIKLADNAYA MEKhanika in Russian Vol 16, No 1, Jan 80 pp 40-46 manuscript received 19 Oct 78

PALAMARCHUK, V.G. and NOSACHENKO, A.M., Institute of Mechanics, Academy of Sciences of the Ukrainian SSR, Kiev

[Abstract] The authors consider a closed truncated conical shell of circular cross section and uniform thickness, reinforced with a regular array of hoops and stringers. This shell carries a mass inside mounted at the center on two horizontal diametrically opposed equally stiff springs. The free vibrations of such a shell are calculated by the energy method on the basis of the linear theory, taking into account the discrete spacing of reinforcement members. Substituting the expressions for potential and kinetic energy of all elements in a Lagrange equation of the second kind yields an infinite system of ordinary differential equations. Seeking the solution in sine terms reduces it to an infinite homogeneous system of algebraic equations. Theoretical and experimental data have been evaluated for a 320 mm high shell made of AMG-6M aluminum-magnesium alloy sheet with the radius of the larger base 160 mm and the radius of the smaller base 85 mm with 2 hoops and 32 stringers made of AMG-6M angle bars. The attached mass inside and the stiffness of the springs were varied, the effect of the mass on the frequency of shell vibrations becoming increasingly significant with decreasing spring stiffness. Figures 3; references 5 Russian. [37-2415]

USSR

UDC 624.074.4:681.3

DYNAMIC OPTIMIZATION OF MULTILAYER CYLINDRICAL SHELLS REINFORCED WITH TWO REGULAR ARRAYS OF MEMBERS

Kiev PRIKLADNAYA MEKhanika in Russian Vol 16, No 1, Jan 80 pp 47-54 manuscript received 4 Sep 78

POCHTMAN, YU.M. and TUGAY, O.V., Dnepropetrovsk Institute of Construction Engineering

[Abstract] Reinforcement of multilayer cylindrical shells with a polyregular array of reinforcing members is considered, such structures being used in aircraft and ship design. The natural frequencies of such shells with the polyregular reinforcement consisting of two regular arrays of

hoops and stringers are calculated by the energy method on the basis of the linear theory. The calculations apply specifically to a closed cylindrical shell of circular cross section and uniform thickness, consisting of s orthotropic layers whose principal elasticity axes coincide with the coordinate axes. The shell is hinge-supported at the ends and subject to axial compressive forces uniformly distributed over the base areas. The layers remain within the elastic range and do not slip, the hypothesis of undeformed normals is held valid for the entire stack. With displacements expressed in monomial form, approximate expressions for the natural frequencies are derived which take into account the discreteness and the eccentricity of reinforcements. The results are used for dynamic optimization of such shells, with the minimum mass as the criterion functional under the constraints that the lowest critical frequency must lie above a given threshold and that the compressive stresses must remain below the critical level. This problem in nonlinear programming has been solved by the method of random search for a single-layer shell with stiff reinforcing hoops and stringers. The authors thank V.A. ZARUTSKIY for the helpful discussion. Tables 1; references 6 Russian. [37-2415]

USSR

UDC 539.3

VARIABLE-THICKNESS CYLINDRICAL SHELLS UNDER LONGITUDINAL AND LONGITUDINALLY VARYING TRANSVERSE LOADS

Kiev PRIKLADNAYA MEKhanika in Russian Vol 16, No 1, Jan 80 pp 55-61 manuscript received 22 Feb 79

MAKSIMENKO, V.P., Institute of Mechanics, Academy of Sciences of the Ukrainian SSR, Kiev

[Abstract] The author considers smooth cylindrical shells with a variable thickness and with reinforcing hoops one at each end. The state of stress and strain under longitudinal and longitudinally varying transverse loads is calculated for four basic forms of constraints, with the shell thickness assumed to vary according to an arbitrary law and the load also allowed to be piecewise discontinuous. The general system of differential equations of equilibrium, geometry, physics, displacements and stresses, according to the technically nonlinear theory of shallow shells, is applied to the case of internal pressure acting simultaneously with an axial force. The resolvent equation is constructed and the boundary conditions written for both hoops with elastic seats, with clamps, with hinge supports or with free supports. A practical solution is obtained upon conversion to a system of finite-difference equations, including the first points but discarding the second

points beyond the hoops. A program has been written for a grid of up to 328 nodes, not including points beyond the hoops, and typical numerical data are shown based on 57, 113, and 225 nodes respectively. Figures 2; tables 2; references 7: 5 Russian, 1 Polish, 1 Western.
[37-2415]

USSR

UDC 621.3.043.2.001.24

VIBRATIONS OF A TURBOGENERATOR STATOR WITH THE CORE ELASTICALLY MOUNTED IN THE FRAME BY MEANS OF TANGENTIAL BARS

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 16, No 1, Jan 80 pp 94-98 manuscript received 23 Aug 77

MAKSIMOV, L.V., Scientific Research Institute of Leningrad Industrial-Experimental Association "Elektrosila," Leningrad

[Abstract] Elastic mounting of the stator core by means of tangential bars in the frame of a turbogenerator is considered, such a construction isolating the frame from elastic vibrations of the core and at the same time firmly holding the core in the frame when both are horizontally or vertically deflected. Vibrations of such a structure are analyzed, both core and frame being regarded as thin elastic rings and the tangential bars assumed to have a relatively negligible mass. The stator is resting on elastic supports assumed to be sufficiently soft so as not to affect the behavior of the system. The analysis starts from the equations of potential and kinetic energy, according to Hamilton's principle, with the condition of periodicity added. An approximate solution for the tangential displacements of both rings is sought in the form of trigonometric series describing the natural modes. On this basis, forced vibrations due to magnetic pull are then calculated for a 2-pole turbogenerator and accordingly the optimum configuration of such a tangential mounting, with diametrical spacing, is determined. Figures 2; references 2 Russian.
[37-2415]

USSR

UDC 62.501

OPTIMAL CONTROL OF THE MOVEMENT OF A VEHICLE FLYING THROUGH A TURBULENT
ATMOSPHERE

VESTNIK MOSKOVSKOGO UNIVERSITETA, SER. 1, MATEMATIKA I MEKHANIKA in Russian,
No 1, Jan Feb 80, pp. 79-83, manuscript received 04 Sep 78

DROZDOV, A. D., Department of Applied Mechanics

[Abstract] A study is made of the motion of a flight vehicle in a turbulent atmosphere in the vertical plane. The vehicle is considered as an absolutely rigid body acted upon by the force of gravity, thrust applied to its center of mass, aerodynamic force, and aerodynamic torque. The rotation of the earth and curvature of the earth's surface are ignored. The equations of motion of the flight vehicle are derived and analyzed. Deviations caused by pulsations in wind speed are considered small. Optimal controls are calculated and their variation with turbulence is analyzed. References 4: 3 Russian, 1 Western.
[36-6508]

NON-NUCLEAR ENERGY

UDC 536.531(088.8)

TEMPERATURE SENSOR THAT IS INVARIANT TO PARAMETERS OF THE HEAT-SENSING ELEMENT

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY PRIBOROSTROYENIYE in Russian
No 1, Jan 80 pp 90-94

[Article by V. V. Sokolenko, Taganrog Radio Engineering Institute imeni
V. D. Kalmykov]

[Text] A temperature sensor is described that is made in a compensation circuit with thermal feedback. The major parameters of the sensor are calculated, and errors are analyzed. It is shown that a high degree of linearity can be attained in the output characteristics. Experimental data confirm the results of calculation.

Methods and equipment for checking and measuring temperature are being constantly improved at the present time. Existing sensors with standardized output signal that are designed around resistance thermometers and thermocouples do not always have satisfactory parameters such as measurement accuracy, speed and so on.

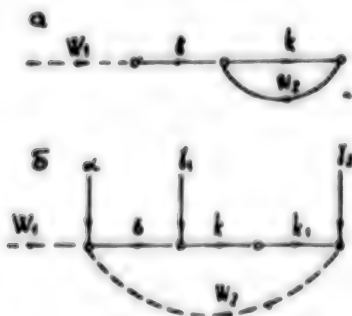


Fig. 1. Signal graph of a temperature sensor with electric feedback (a) and with thermal feedback (b)

The precision of temperature sensors can be increased by using compensation circuits for temperature conversion, the most promising being the use of thermometric parameters of transistors, which have higher temperature sensitivity than other elements.

Information is available on temperature sensors [Ref. 1, 2] in which the temperature dependence of voltage across a p-n junction is used as the heat-sensitive parameter. The temperature coefficient ϵ of this voltage is held constant only if the current through the junction is held invariant. The change in current due to temperature is compensated by a circuit with an operational amplifier

that tracks this change. The signal graph of such a sensor is shown in Fig. 1. From this graph, we can write the "input-output" transfer function of the sensor as

$$H = \frac{W_1 \cdot k}{1 + k W_2} \approx \frac{W_1}{W_2} \epsilon, \quad (1)$$

where W_1 is a coefficient determined by the design of the sensor; W_2 is the dimensionless transfer constant for the electrical input versus the electrical output of the sensor; ϵ is the coefficient of heat sensitivity of the element; k is the gain of the amplifier.

As implied by (1), in this system with feedback with respect to the electric signal, the transfer function H depends on the coefficient of heat sensitivity ϵ . The dependence of the output parameter of the sensor on the specific type of the heat-sensing element that is used considerably limits the choice of semiconductor device that can be used and the tolerances on its parameters when designing sensors with a standardized output signal.

Use of the principle of invariance in the design of measuring instruments [Ref. 3] enables construction of a sensor with output signal that is not sensitive to scatter of the parameters of heat-sensing elements. The block diagram of such a sensor utilizes thermal feedback in contrast to those considered in Ref. 1, 2, in which electric feedback is used. The schematic circuit of the proposed pickup and its graph are shown in Fig. 1b and 2. The sensor operates as follows. A heat-sensing element based on transistor V1 converts the temperature coming from the ambient medium and from an internal heat source based on transistor V2 into an electric signal. A signal from transistor V1 goes to the noninverting input of opamp A1, and a signal from the divider based on resistors R1, R2 goes to the inverting input. The mismatch voltage amplified by opamp A1, which has a gain of k , is applied via resistor R4 to the input of amplifier A2, and changes the power dissipated in heat source V2. A rise in ambient temperature reduces the power dissipated in the heat source, and vice versa. The temperature of the heat-sensing element during operation of the sensor remains constant thanks to a closed self-regulation system.

We will analyze the operation of the sensor and determine its major parameters with the following assumptions:

- settling of transient processes in the heat source takes place much more rapidly than a change in ambient temperature;
- the conditions of heat exchange between the structure of the sensor and the ambient medium do not change during operation;
- the ambient temperature being measured by the sensor does not exceed the rated limits.

With consideration of the action of destabilizing factors (see Fig. 1b) and the independence of their action, the transfer function for the sensor in general form is

$$H \cong \frac{W_1 k + \alpha k + \gamma_2 k}{1 + (\alpha k k_1 + \alpha k_1 k + \gamma_1 k_1 k E + \gamma_2 E) W_2}, \quad (2)$$

where W_1 is the dimensionless transfer constant for the measured ambient temperature versus the temperature of the heat-sensing element; W_2 is a coefficient with dimensions of heat-transfer resistance; k_1 is the coefficient of conversion of the mismatch signal to electric power; α , γ_1 , γ_2 are coefficients that account respectively for the change in heat conduction in the channel comprising the measured medium and the heat-sensing element, the change in voltage across the heat-sensing element, and the change in voltage across the heat source. For a sufficiently high gain of opamp A_1 and stable thermophysical characteristics of the material of the heat-transfer medium, the expression for the transfer function is simplified:

$$H \cong \frac{W_1}{W_2 k_1}. \quad (3)$$

To determine the output characteristic of the sensor it is necessary to find the functional relation between the mismatch voltage and the power dissipated in the source V_2 .

Amplifier A_2 is covered by deep negative feedback through the forward-biased base-emitter junction of transistor V_2 with inputs that can be considered equipotential. In this case the current through the transistor is determined solely by the supply voltage and the value of resistor R_4 :

$$P = I_{CE} E + I_{BE} U_{BE} = \frac{U_{max}}{R_4} \left(E + \frac{U_{BE}}{\beta} \right), \quad (4)$$

where U_{BE} is the base-emitter voltage of transistor V_2 ; β is the gain of transistor V_2 ; I_{CE} is the current through transistor V_2 , U_{BEX} is the output voltage; and E is the voltage of the power supply.

Equation (4) implies that the power dissipated in transistor V_2 depends linearly on the voltage applied to resistor R_4 .

The following balance equation can be set up for the sensor circuit in the steady state:

$$(PW_2 + T_c W_1) k - U_{max} = 0, \quad (5)$$

where k is the gain of amplifier A_1 , U_{BEX} is the output voltage of the sensor, P is the power dissipated in the heat source V_2 , and T_c is the ambient temperature being measured.

The output characteristic of the sensor with consideration of (3), (4), (5) and the assumptions made ($W_1 = 1$) is written in the form of the expression

$$U_{out} = - \frac{R_4}{(E + U_{BE}/\beta) W_2} T_c. \quad (6)$$

When the product in the denominator of (6) is constant, the output characteristic is linear. Since the closed regulating system keeps the temperature of the heat-sensing element constant within set limits, and the heat source is in direct proximity to the heat-sensing element, W_2 is constant. The error δ_U is due to the temperature dependence of the second term in the denominator of (6):

$$\delta_U = \frac{U_{BE}\beta' - U_{BE}'\beta}{(E + U_{BE}/\beta)\beta}, \quad (7)$$

where β' and U_{BE}' are the temperature derivatives of the gain of transistor V2 and of the base-emitter voltage respectively.

Calculation shows that the relative error of the output voltage of the sensor is slight, and for a transistor gain of $\beta = 100$ is $(1-3) \cdot 10^{-3}\%$ per degree, which can be disregarded in practical calculations.

Thus the output characteristic of the sensor (6) is linear, and is described by an equation of a straight line with slope

$$S = \frac{R_4}{(E + U_{BE}/\beta) W_2}. \quad (8)$$

The sensitivity of the sensor (8) during manufacture can be predetermined by changing electric parameters R_4 , E and structural-technological parameters W_2 . Error (7) can be reduced by appropriate selection of the structural and electrical parameters of the sensor elements.

The ranges of measurable temperatures are determined chiefly by heat-transfer resistance W_2 and by the range of variation in the power released in the heat source. When the sensor operates within the rated limits, the power released in the heat source varies so that $P_1 W_2 + T_{c1} = P_2 W_2 + T_{c2} = T$, where T_c , P , T are respectively the instantaneous ambient temperature, the corresponding power dissipated in the heat source, and the temperature of the heat-sensing element.

The temperature limits T_{cmin} , T_{cmax} are measured at

$$T = \begin{cases} P_{max} \cdot W_2 & \text{at } T_{cmin}, \\ T_{cmax} & \text{at } P = 0. \end{cases}$$

The limiting value of the temperature range is determined by the permissible temperature of the working medium of the heat-sensing element

in the range of power variation in the heat source. Considering that opamps operate on a load of no more than 1000 ohms at a potential of 10-18 V, the temperature range of the sensor at a heat-transfer resistance of 1000 K/W is 200-400°C.

The range of sensitivity of the sensor with the proposed circuit can be regulated from 1000 to 0.01 V per degree, depending on the value of W_2 and the electrical working conditions.

As implied by (6), the output parameter of the sensor is invariant to the sensitivity of the heat-sensing element. This means that sensors can be designed around heat-sensing elements with a considerable difference in the form of the temperature characteristics, their spread, and sensitivity. This is especially important when such sensors are mass-produced as chips, where it is not possible to select for identical heat-sensing elements. The identity of characteristics of the given sensor is realized by the repeatability of design and technological parameters, since all designs in manufacture use the same set of phototemplates, the same initial material, and go through the same technological cycle. As a result, parameter W_2 is maintained with an error that does not exceed 1%.

Experimental studies were done on sensors made according to the circuit of Fig. 2 with heat-sensing elements and heat sources based on K1NT291V microcircuits. Two design modifications were studied. In the first,

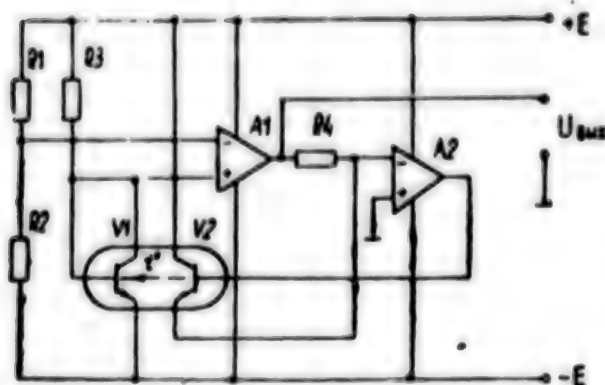


Fig. 2. Schematic diagram of a temperature sensor that is invariant to changes in the parameters of the heat-sensing element

the crystal of the microcircuit was suspended on its own leads, 30 μ m in diameter, and 10 mm long. In the second modification, the sensor was made entirely in the form of a hybrid integrated circuit enclosed in a type 151-15.1 case. All elements of this hybrid circuit were accommodated on a crystal backing 0.6 mm thick cemented to the base of the enclosure. The first design modification used encased opamps of type EL741C, and the second used unencased opamps type 740UD5-1.

The sensitivity of sensors with ± 12 V supply and load resistor of

$R_4 = 3000$ ohms was 0.10 V/K in a temperature measurement range of 20-120°C and 0.3 V/K in a range of 20-60°C for the first and second designs respectively. The sensitivity spread of several sensors of the first design (only the sensing probe containing the K1NT291V microcircuits was changed) did not exceed 2%, while the sensitivity spread for the second design, as measured on ten microcircuits, was no more than 3.5%. The output characteristics found in the course of the experiment were linear

within the limits of error of the measuring instruments. The results agree well with the calculated values.

This sensor may be used not only for temperature measurement, but also for measuring the velocity and flowrate of liquids and gases, and for measuring the inhomogeneity of particulate, gaseous and liquid materials.

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2. Nezer, "A Thermometer Based on a Diode and Four Opamps," ELEKTRONIKA, No 11, 1977, p 58.
3. B. N. Petrov, V. A. Viktorov, V. V. Lunkin, A. S. Sovlukov, "Printsip invariantnosti v izmeritel'noy tekhnike" [The Principle of Invariance in Measurement Technology], Moscow, "Nauka", 1976.

[8144/0906-6610]

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6610

CSO: 8144/0906

USSR

UDC 621.952:621.921.34

SYNTHETIC DIAMOND DRILLS WITH HIGH WEAR RESISTANCE

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST' in Russian No 10, 1979
pp 49-51 manuscript received 14 Aug 78

MASLOV, V. P., GRISHACHEV, V. P., MEL'NIK, T. S., PORTNOVA, YE. A. and
SERGIYENKO, YE. A.

[Abstract] The paper gives the results of studies of 12 mm tubular drills based on modified copper binder with synthetic metallized diamonds. The hardness of the metallized diamonds is 1.5-2 times as high as that of the initial diamonds. The wear resistance of the drills was determined from the specific consumption of diamonds in carats per meter, the durability of the drill on the end surface in mm/m, using conventional methods. The surface roughness was measured on a model M-201 profilometer-profilograph. The tests were done on 30-115M glass-ceramic at a speed of 2000 rpm and feed of 5-20 mm/min using a water-base coolant. The results show that the durability of drills equipped with synthetic diamonds of mixed granularity (ASV 125/100-SAM 80/63, coated) is 1.2-1.5 times as high as for drills of natural diamonds with granularity of 200/160. The roughness of surfaces machined with such drills is class eight with an affected layer 3-10 μ m deep as compared with sixth class roughness and an affected layer 10-30 μ m deep for conventional drills of natural diamonds. Durability of the drills is better because of improved adhesion between the metallized diamonds and the binder and because of increased density of the distribution of diamonds on the cutting surface. Figures 2, references 4 Russian.
[33-6610]

USSR

UDC 539.234

MULTILAYER VACUUM COATINGS BASED ON LAYERS OF TITANIUM DIOXIDE AND SILICON DIOXIDE

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST' in Russian No 11, 1979
pp 59-61 manuscript received 28 Jul 78

CHEREpanova, M. N. and TITOVA, N. F.

[Abstract] An examination is made of the methods of sputtering and the optical characteristics of multilayered coatings of titanium dioxide and silicon dioxide for purposes of beam splitting, reflection and cutting off short-wave and long-wave regions of the spectrum. The optical properties of the layers are determined by the sputtering rate, the temperature of

the backing and the vacuum during deposition. The index of refraction and absorptivity of titanium dioxide layers depend on the degree of oxidation of the material being sputtered. Sputtering is done in oxygen to get non-absorptive layers. The index of refraction of the layers increases with the temperature of the backing. Coatings with reflectivity of more than 99% were obtained, as well as beam splitters with different color-selective properties in the wavelength range of 0.4-2.5 μm and reflectivity of less than 99%. Transmission curves are given for multilayer filters that cut off the short-wave and long-wave regions of the spectrum. Figures 2, references 7: 4 Russian, 3 Western.
[34-6610]

USSR

UDC 539.1.08

OPTIMIZATION OF COLLIMATING UNITS OF GAMMA CHAMBERS WITH TIME MODULATION OF THE SIGNAL

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 6, Nov Dec 79 pp 47-49
manuscript received 6 Mar 78

FEDOROV, G. A., Moscow Engineering Physics Institute

[Abstract] Recently developed internal flaw detectors, principally gamma chambers, are equipped with aperture plates that code the recorded information. These detectors use either space or time modulation of the signal. Collimators for space modulation are various modifications of Fresnel zone plates, or aperture plates with a random or regular array of pinholes. In the case of time modulation, the collimators are aperture plates with pinholes or channels that are covered in accordance with a specified rule during measurements. The author describes collimators that are optimum with respect to a statistical image quality criterion for gamma chambers with time modulation of the signal. The optimization is based on a class of (0,1)-matrices that describe the configuration of the channels in the collimator. Figures 3, references 16: 8 Russian, 8 Western.
[27-6610]

DETERMINATION OF THE AMPLITUDE OF DEFORMATION IN AN ULTRASONIC WAVE AT HELIUM TEMPERATURES

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 6 Nov Dec 79 pp 142-144
manuscript received 3 Jul 78

PAL'-VAL', L. N., PAL'-VAL', P. P. and PLATKOV, V. YA., Physicotechnical
Institute of Low Temperatures, Academy of Sciences UkrSSR, Khar'kov

[Abstract] Conventional techniques for determining the absolute value of deformation when the ultrasonic pulse method is used to study the electronic properties of solids or the dynamic behavior of crystal dislocations are complicated and require special precision equipment that is not convenient for wide temperature ranges. The authors propose a simple method of determining deformation amplitude based on the thermal action of an ultrasonic wave. If a specimen in which ultrasonic vibrations are set up is not under adiabatic conditions, the temperature of the specimen under steady-state conditions is set so that the dissipated ultrasonic energy compensates for thermal losses to the ambient medium. If ultrasonic heating is replaced by an electric heater in contact with the specimen, the dissipated energy is equal to the voltage drop across the heater multiplied by the current, and deformation can be determined from the formula $e_0 = (8\sqrt{pUI}/\pi d^2 E^3 \tau_1 f)^{1/2}$, where p is density, U is the voltage drop across the heater, I is current, d is the diameter of the emitter, E is Young's modulus, τ_1 is pulse duration, and f is the pulse recurrence rate. The sensitivity of the method improves with heat transfer to the ambient medium and with a reduction in the specific heat of the specimen. Figures 3, references 15: 8 Russian, 7 Western.
[27-6610]

AN INSTRUMENT FOR MEASURING THE INHOMOGENEITY OF A MAGNETIC FIELD

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 6, Nov Dec 79 p 172
manuscript received 17 Apr 78

BYSTROV, YU. A., ZAGRANICHNYY, YE. N. and RADCHENKO, YU. F.

[Abstract] The main element of the instrument is a field inhomogeneity sensor comprised of a vacuum tank accommodating a cathode and an even number of anodes. Each anode is made up of two pairs of sections on different sides of the cathode. The sections of each anode are cross connected. Two sections of each of the anodes are located to one side of the cathode, and the other two sections are located to the other side. During measurements, the unit is placed so that the lines of magnetic force coincide with the

axis of this electrode system. This places the electron flux of the sensor in crossed electric and magnetic fields, and when there is a deviation of the electron flux, the anode currents are redistributed between the sections. If the field is homogeneous, the electron flux will be the same in the different sections, and the output voltage of the sensor will be zero. If the field is inhomogeneous, there will be no compensation, and the output voltage will be proportional to the degree of inhomogeneity. The output response is linear up to 1 T/m. The unit also contains a power supply and display. Induction measurement range is 0.01-0.1 T, sensitivity is 10 V/(T/m), frequency range 0-10 MHz, output impedance 500 ohms, warmup time 10 minutes, distance between sensor and recording equipment up to 30 m. Power consumption is less than 50 W from a 220 V line. Weight is less than 3 kg. Figure 1. [27-6610]

USSR

UDC 536.7:531.756

A FACILITY FOR MEASURING THERMODYNAMIC PARAMETERS OF LIQUIDS

Moscow PRIBORY I TEKHNIKA EKSPERIMENTS in Russian No 6, Nov Dec 79 p 173
manuscript received 28 Feb 78

KHAYUTIN, YU. D.

[Abstract] This installation is designed for studying the thermodynamic properties of freons, and may be used with hydrocarbons and other liquids that are not aggressive to copper alloys or Kh18Ni9Ti steel. The working principle involves the way that the period of oscillations of a torsional pendulum depends on its inertia. A thin-walled torus with radial partitions is entirely filled with the test liquid and undergoes undamped torsional oscillations about its vertical axis. The period of the stabilized oscillations is measured by an F-599 frequency meter-chronometer. The digital output can be recorded by an F595-KM printer or sent to a computer. Accuracy of measurement of specific volume is about 0.1%. Constant temperature is maintained by double thermostating (liquid-gas) and measured by a platinum resistance thermometer or equal-division mercury thermometers. Zero temperature difference between the thermostating gas and the test liquid is monitored by a three-junction differential thermocouple and F18 microvoltmeter. Working temperature range is from -100 to +100°C. The thermostating gas is the pressure source, transmitted through a bellows connected to the inner cavity of the pendulum through a flexible capillary. Pressure is measured by a manometer. Maximum working pressure is 6 MN/m². Figure 1, references 2 Russian. [27-6610]

USSR

UDC 621.438

CALCULATION OF THE EFFICIENCY REDUCTION OF A GAS TURBINE UNDER THE INFLUENCE OF AIR COOLING

Kazan' IZVESTIYA VUZov: AVIATSIONNAYA TEKHNICA in Russian No 3, 1979 pp 14-22 manuscript received 25 Jun 78

BOGOMOLOV, YE. N.

[Abstract] An analysis is made of the way that air cooling reduces the efficiency of a gas turbine based on the idea that operation of the cooling system changes the available energies in the turbine (the main flow of working fluid and coolant). The results show that the decisive factor that influences losses in the turbine due to the cooling system is the relative flowrate of coolant. A reduction in the flowrate of air always reduces losses, even when the reduction in flowrate is achieved by increasing the drag in the vanes. At the same time, reducing flowrate by increasing drag results in an increased percentage of the losses per unit of relative reduction in vane temperature, whereas the reduction in relative flowrate of cooling air resulting from a reduction in the relative work of compression of the coolant or an increase in the ratio of the peripheral component of coolant velocity preceding the rotor to the peripheral velocity of the rotor on the radius where the cooling air enters, is accompanied by a reduction in the fraction of total losses per unit of reduction in blade temperature. Figure 1, references 12 Russian. [35-6610]

USSR

UDC 629.7.036.3

ANALYTICAL DESIGN OF A TURBINE BLADE

Kazan' IZVESTIYA VUZov: AVIATSIONNAYA TEKHNICA in Russian No 3, 1979 pp 83-86 manuscript received 10 Jan 79

GORODETSKAYA, S. M.

[Abstract] The author considers a method of automated blade design with consideration of the following requirements: 1. the blade surface must pass through three given cross sections; 2. the cross sections of the blade must have good gasdynamic properties: predetermined smoothness, no change in the sign of curvature and no discontinuities, given radii of leading and trailing edges, given angles of flow inlet and outlet; 3. the areas of the blade cross sections must change in accordance with a given

law; 4. the centers of gravity of the blade cross sections must lie on a given space curve. Analytical expressions are derived by the method of cubic splines. References 2 Russian.
[35-6610]

USSR

UDC 621.438.536.24

INVESTIGATION OF THE PARTICULARS OF THE WORKING PROCESS OF THE EVACUATING UNIT OF A GAS TURBINE ENGINE WITH STEPWISE HEAT REMOVAL

Kazan' IZVESTIY VUZov: AVIATIONNAYA TEKHNIKA in Russian No 3, 1979
pp 89-92 manuscript received 7 Jun 76

DOMRACHOV, A. V. and PEREL'SHTEYN, B. KH.

[Abstract] The authors describe an evacuating unit for a gas turbine engine with stepwise heat removal, and a test stand for investigating the peculiarities of such units. The evacuating unit is self contained, i. e. it has no mechanical connections with the main engine and includes an overexpansion turbine, a cooler and separator compressor. Such units can also be used on production lines, using the waste gas of chemical and metallurgical processes to produce electricity, for refrigeration and to provide vacuum. The test stand is made up of components of a series-produced gas turbine engine. Among the particulars that must be studied on these units is the fact that the Reynolds numbers in the flow section are much lower than in conventional gas turbine engines, the efficiency of the cooler and separator compressor are influenced by factors such as deposits, corrosion and erosion because of operation in an atmosphere of combustion products, and transient conditions in the separator compressor are considerably different from those in the compressor of a conventional gas turbine engine. Figures 3, references 4 Russian.
[35-6610]

USSR

UDC 621.438-621.532-181.4

INFLUENCE THAT UPPER AND LOWER OVERLAPS HAVE ON THE EFFICIENCY OF A PARTIAL AXIAL AIR MICROTURBINE

Kazan' IZVESTIYA VUZov: AVIATIONNAYA TEKHNIKA in Russian No 3, 1979 pp 106-108 manuscript received 10 Jun 78

MUSATKIN, N. F. and TIKHONOV, N. T.

[Abstract] Experiments were done to determine the influence that the upper and lower overlaps have on the internal efficiency of a partial air micro-turbine. The degree of partiality was varied by plugging some of the channels of the nozzle assembly. It is found that the optimum overlap is a linear function of the degree of partiality, and that the optimum value of overlap decreases considerably with a reduction in the degree of partiality. An empirical formula is proposed for calculating the optimum values of upper and lower overlap for a given degree of partiality in a given range of expansions. Figures 3, references 2 Russian.
[35-6610]

USSR

UDC 621.45.00.1121

SOME PROPERTIES OF BYPASS TURBOFAN ENGINES

Kazan' IZVESTIYA VUZov: AVIATIONNAYA TEKHNIKA in Russian No 3, 1979 pp 110-113 manuscript received 15 Feb 79

FISHBEYN, B. D.

[Abstract] The author considers the advantages of a turbofan bypass engine with intermediate loop, and derives formulas for the optimum amount of air takeoff into the intermediate loop that maximizes the specific impulse. Figures 4, references 5: 4 Russian, 1 Western.
[35-6610]

USSR

UDC 621.438.001.4

METHODS OF CORRECTING THE PARAMETERS OF SMALL-SIZE GAS TURBINE ENGINES

Kazan' IZVESTIYA VUZov: AVIATIONNAYA TEKHNIKA in Russian No 3, 1979 pp 113-117 manuscript received 2 Mar 78

SHVETSOV, A. I. and LADOSHIN, A. M.

[Abstract] A method is considered for adjusting the parameters of small gas turbine engines by changing the productivity of the compressor and the area of the guide vane assembly of the turbine. A system of equations is set up for the relations between small deviations of parameters of the working process when control ensures constant rpm, power, and atmospheric conditions at the intake. The turbine and outlet nozzle are treated as a single unit. It is shown that engine performance can be improved by trimming the leading edges of vanes to expand the diffuser. Curves are given for the resultant changes of engine parameters -- fuel consumption, air pressure behind the compressor and gas temperature behind the turbine as a function of air takeoff behind the compressor. Figures 2, references 2 Russian. [35-6610]

USSR

UDC 621.438-253.5:536.245

INFLUENCE THAT LONGITUDINAL SURFACE CURVATURE HAS ON THE TEMPERATURE STATE OF TURBINE BLADES WITH FILM COOLING

Kazan' IZVESTIYA VUZov: AVIATIONNAYA TEKHNIKA in Russian No 3, 1979 pp 122-124 manuscript received 13 Oct 78

SHCHUKIN, A. V. and ZAMALYUTDINOV, M. M.

[Abstract] Analysis is made of the influence that longitudinal curvature of the vane surface has on the temperature state of a turbine blade with film cooling in a high-temperature gas turbine engine. The boundary conditions of heat exchange (efficiency of film cooling and coefficient of heat transfer) are calculated, followed by computation of the temperature state of the nozzle blade with and without consideration of longitudinal curvature of the surface. The results show that disregarding the influence of longitudinal curvature of the surface, i. e. calculating the boundary conditions of heat exchange according to recommendations for a flat plate, may lead to considerable errors in calculation of temperatures. In determination of coolant flowrates, these errors may reach 10% or more, and the error in evaluation of strength reserve may reach 12%. Figures 3, references 9 Russian. [35-6610]

EFFECT OF HYDRODYNAMIC FORCES IN SEALS ON THE ROTOR STABILITY IN A TURBO-MACHINE

Moscow MASHINOVEDENIYE in Russian, No 1, Jan Feb 80 pp 17-23 manuscript received 4 Apr 78

OLIMPIYEV, V. I., Leningrad

[Abstract] The problem of rotor stability in a steam turbine is analyzed by considering not only the hydraulic characteristics of seals between rotor and stator but also the twist of the flow through the seal channels due to a circumferential component of velocity. A weightless rotor shaft on isotropically compliant bearings and coaxial with the stator is assumed to carry an ideally balanced mass at the center and symmetrically on both sides two identical seals of an incompressible fluid fed from a set of nozzles. The differential equations of motion and force balance taking into account the twisted flow yield a sixth-order characteristic equation, which is here approximated by linearization of nonlinear forces and simplification of small linear nonconservative forces near the stability limit. The solution defines the stability criteria, with ranges of "positive" and "negative" friction. Calculations for nine variants of a unicameral seal design with different configurations of inlet and outlet orifices indicate that stability of the rotor depends not only on its natural frequency, on external damping, on the seal construction and on the circumferential stream velocity but also on the density of the sealing medium and on the pressure drop across it. The possibility of destabilizing hydrodynamic forces appearing in a seal in the absence of a circumferential velocity has also been demonstrated experimentally with a seal on top of a vertical cantilever steel beam in an air stream under atmospheric pressure. Figures 5; references 9: 7 Russian, 2 Western.
[32-2415]

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